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Diffusion of dopants in nanostructured black silicon for application in solar cells

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Black silicon is a promising material for solar cells as its nanostructured surface can suppress optical reflection in a broad spectral range [1]. This eliminates the need for a conventional antireflective coating, although a passivation layer is still required to minimize surface recombination [2]. Black silicon also has the potential to increase cell efficiency thanks to its superior absorption of light [2][3]. The majority of industrial silicon cells consist of a p-type silicon substrate into which phosphorous is diffused using a liquid POCl_3 source at high temperatures, thus creating the p-n junction [4][5]. Since black silicon has characteristic features in the range of 100-500 nm, diffusion of phosphorous is challenging to characterize with standard methods such as the macroscopic 4-point probe, and therefore to optimize [6]. This is one of the issues that make black silicon difficult to introduce in standard production lines of solar cells. Here, we have investigated the effect of temperature and time during of the doping process (which consists of deposition of a phosphorous-doped glass and a phosphorous drive-in step) on the reflectivity and sheet resistance of black silicon fabricated by reactive ion etch. Our results show that decreasing temperatures and times during the doping process, as compared to values often used on conventionally wet-textured silicon by the industry, provide more suitable values of reflectivity and sheet resistance for device fabrication.

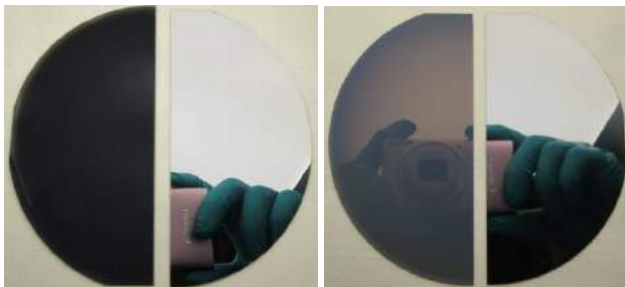


Figure 1: Left shows black silicon and silicon doped at 850°C with a time of 15 min. Right shows black silicon and silicon doped at 1050°C with a time of 30 min. This demonstrates the impact of high temperatures and time on the reflectivity of black silicon.

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